

DRAFT

**78527**

Granulitic Noritic Breccia

5.16 grams

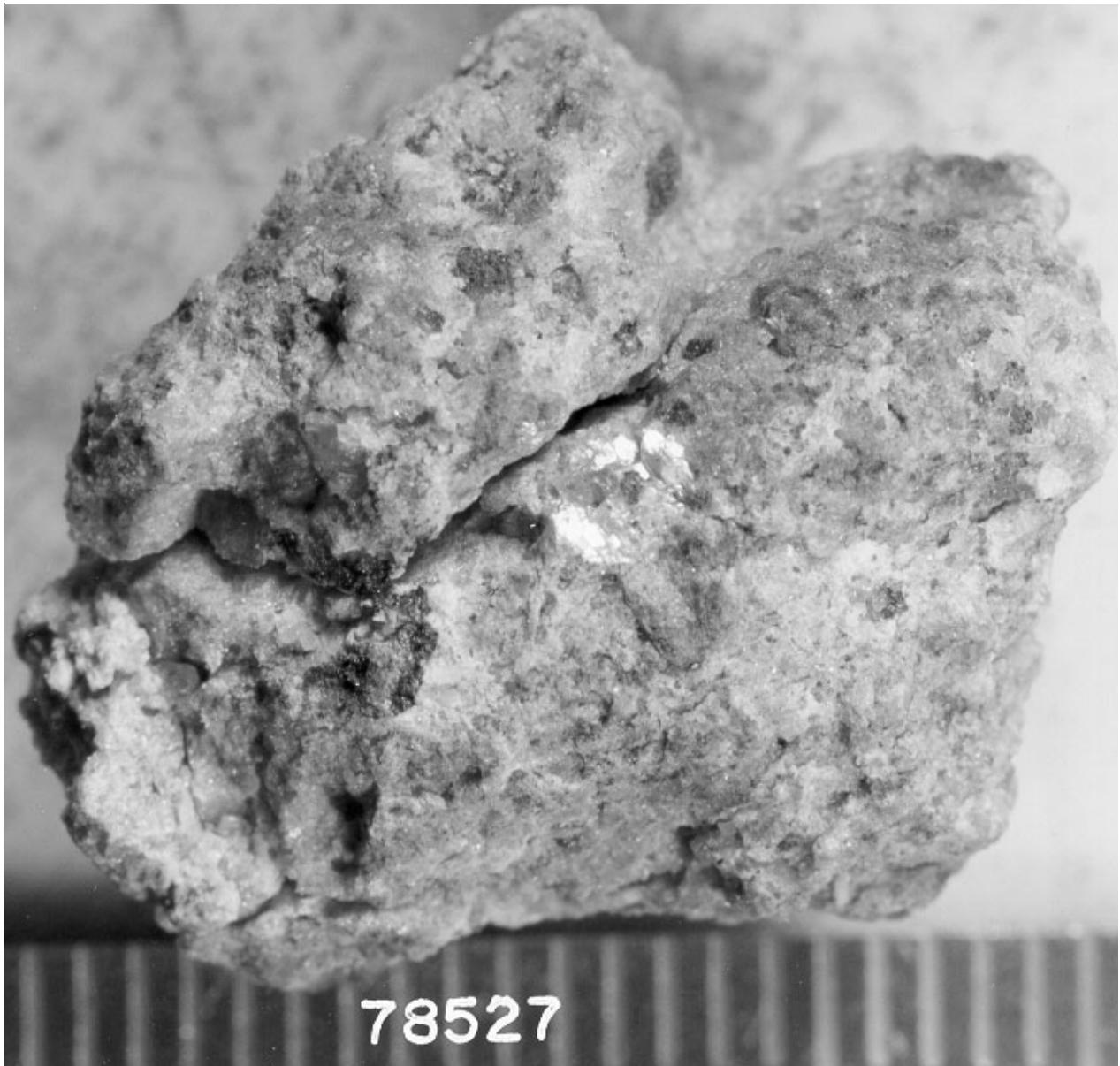


Figure 1: Photo of 78527 showing shocked norite. NASA S73-21026. Scale in mm. Note the zap pit. (the bright spot in the middle is an artifact)

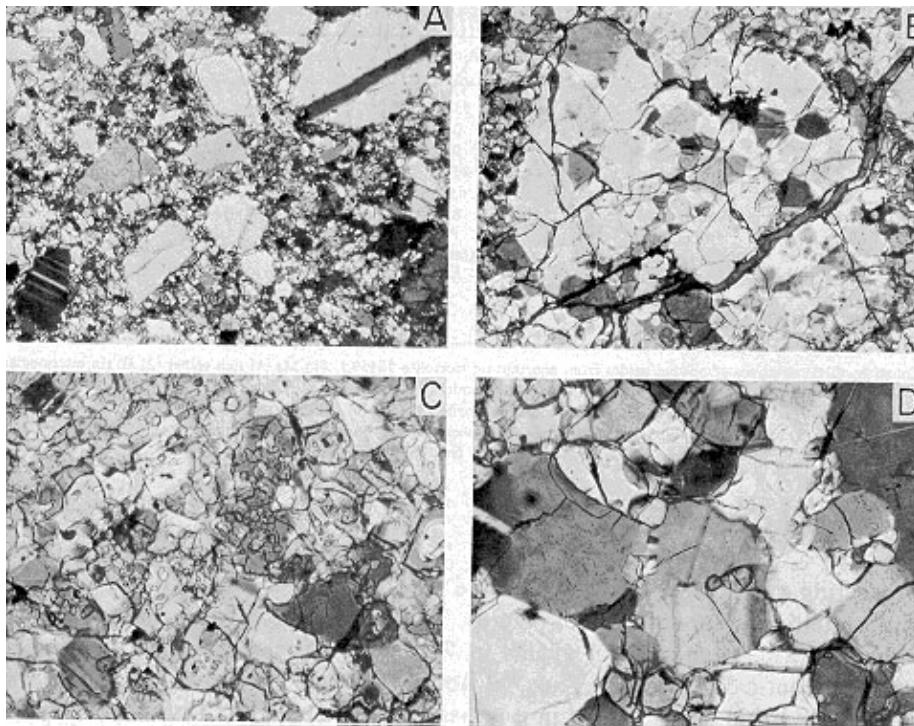
## Introduction

Rake sample 78527 has the mineralogy of a norite, but Cushing et al. (1993, 1999) and Dalrymple and Ryder (1996) refer to this samples as a “granulite” and found that it had an old age (4.146 b.y.).

### Mineralogical Mode for 78527

Warner et al. 1978

Olivine	1.9 %
Pyroxene	45.6
Plagioclase	52.2
Opaque	0.1
Other	0.2



*Figure 2: Photomicrographs of thin section 78527, a) overall texture showing large, subrounded plagioclase in finer-grained matrix. Field of view is 2.4 mm. b) polygonized olivine grain 0.9 mm, c) matrix 0.45 mm. d) matrix 0.45 mm. Nehru et al. 1978.*

## Petrography

Nehru et al. (1978) and Warner et al. (1978) describe rake sample 78527 as a recrystallized norite with approximately equal amounts of orthopyroxene and plagioclase. Minor phases include olivine, augite, armalcolite, ilmenite, rutile, chromite, baddeleyite, zirconolite, zircon, K-feldspar, metal and troilite.

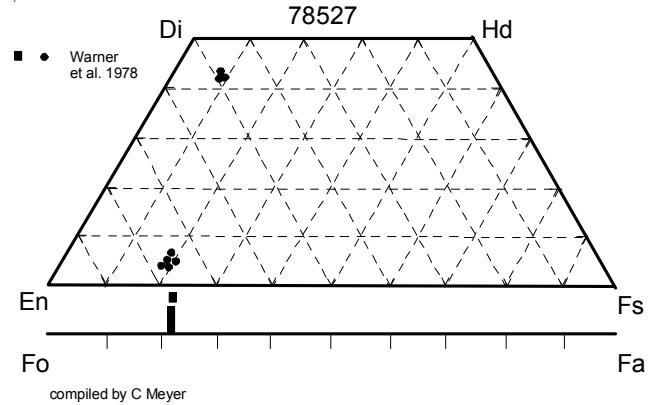
The rock consists of large seriate, subangular plagioclase (up to 2 mm) and orthopyroxene (up to 0.8 mm) crystals in a fine-grained recrystallized matrix (figure 2). Minor olivine occurs as large polygonized grains. Cushing et al. (1999) determined the “equilibrium temperature” of 78527 from pyroxene composition as 1061 deg. C.

## Mineralogy

**Olivine:** The olivine in 78527 is  $\text{Fo}_{77}$  (Nehru et al. 1978).

**Pyroxene:** Warner et al. (1978) illustrate the pyroxene compositions in 78527 (figure 3).

**Plagioclase:** Plagioclase in 78527 is  $\text{An}_{93.94}$  (Nehru et al. 1978).



*Figure 3: Pyroxene and olivine composition of 78527 (data replotted from Warner et al. 1978, Nehru et al. 1978).*

**Opacites:** The composition of ilmenite, armalcolite and chromite are given in Warner et al. (1978).

**Metallic iron:** Metal grains in 78527 are all high in Ni (25-53%) and Co (1.9-2.2%).

## Chemistry

Laul and Schmitt (1975), Murali et al. (1978), Warren et al. (1983) and Dalrymple and Ryder (1996) analyzed

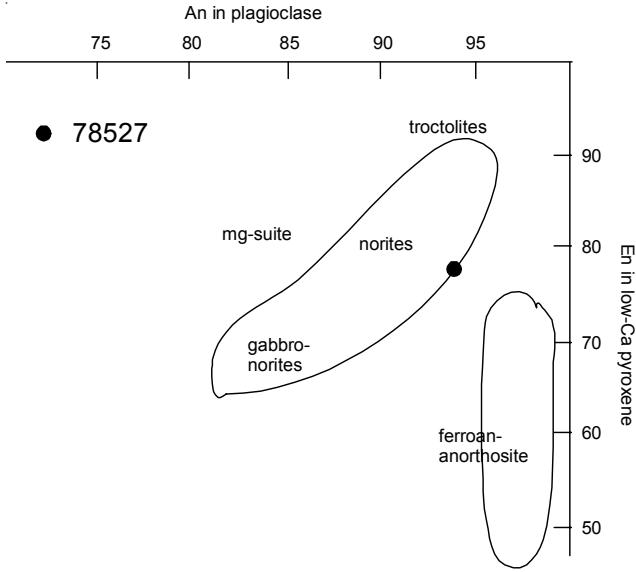


Figure 4: Plagioclase/pyroxene composition for 78527 norite (Nehru et al. 1978).

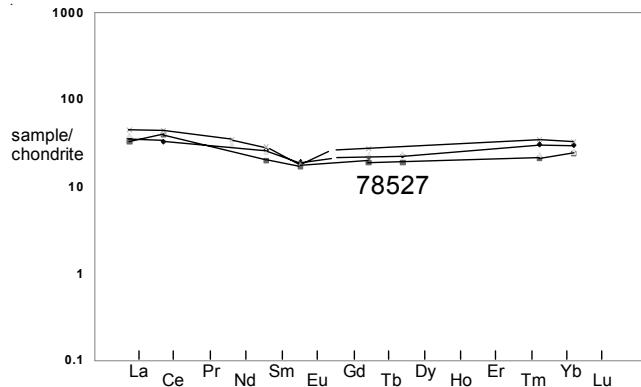


Figure 5: Normalized rare-earth-element diagram for 78527 (data from Laul and Schmitt 1975, Murali et al. 1977, Warren et al. 1983 and Dalrymple et al. 1996).

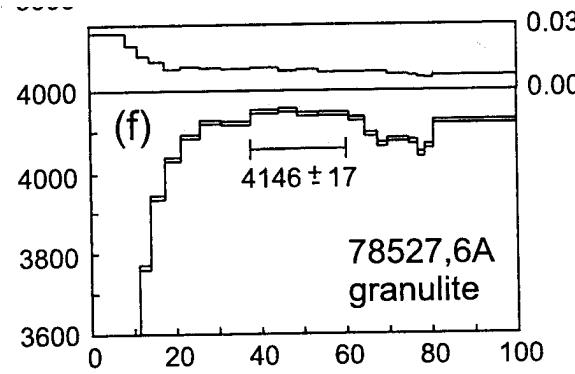


Figure 6: Ar/Ar release pattern for 78527 (from Dalrymple and Ryder 1996).

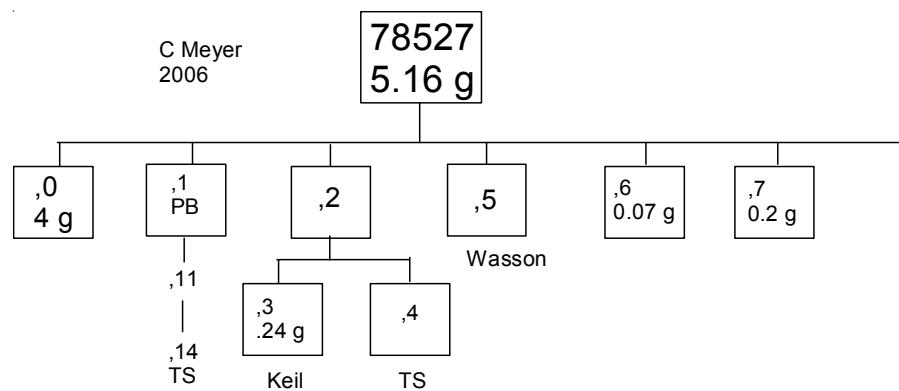
### Summary of Age Data for 78527

Dalrymple and Ryder 1996     $4.146 \pm 0.017$  b.y.

78527 (table 1, figure 5). They found high Ir (*leading Paul Warren to declare that 78257 is “marginally probably pristine”*).

### Radiogenic age dating

Dalrymple and Ryder (1996) dated 78527 as 4.146 b.y. by the Argon 39/40 release plateau (figure 6).



**Table 1. Chemical composition of 78527.**

reference	Laul75	Murali77	Warren83 clast?	Dalrymple96	
SiO <sub>2</sub> %			45.5	(b)	48
TiO <sub>2</sub>	0.6	0.38	(a) 0.37	(b) 0.5	(a)
Al <sub>2</sub> O <sub>3</sub>	16.8	13.3	(a) 14.9	(b) 14.4	(a)
FeO	7.4	8.3	(a) 9.9	(b) 9.2	(a)
MnO	0.09	0.087	(a) 0.12	(b) 0.13	(a)
MgO	15	14	(a) 19.75	(b) 18.9	(a)
CaO	9.2	7.8	(a) 8.12	(b) 8.1	(a)
Na <sub>2</sub> O	0.42	0.36	0.35	(a) 0.37	
K <sub>2</sub> O	0.065	0.054	0.07	(b) 0.09	
P <sub>2</sub> O <sub>5</sub>					
S %					
<i>sum</i>					
Sc ppm	9.4	8	(a) 9.4	(a) 12.2	(a)
V					
Cr	1437	1307	(a) 1470	(a) 1763	(a)
Co	31.6	35	(a) 47	(a) 40	(a)
Ni	120	170	(a) 102	(a) 142	(a)
Cu					
Zn			3.3	(a)	
Ga			3.2	(a)	
Ge ppb			86	(a)	
As					
Se					
Rb					
Sr				119	(a)
Y					
Zr		<350	(a) 132	(a)	
Nb					
Mo					
Ru					
Rh					
Pd ppb					
Ag ppb					
Cd ppb		3.8	(c )		
In ppb					
Sn ppb					
Sb ppb					
Te ppb					
Cs ppm				0.16	(a)
Ba	150	110	(a) 140	(a) 130	(a)
La	8.5	7.9	(a) 9.3	(a) 10.6	(a)
Ce	20	25	(a) 25.5	(a) 26.9	(a)
Pr					
Nd			14	(a) 15.8	(a)
Sm	3.9	2.9	(a) 3.72	(a) 4.3	(a)
Eu	1.07	0.97	(a) 0.98	(a) 1.04	(a)
Gd					
Tb	0.8	0.7	(a) 0.83	(a) 1	(a)
Dy	5.5	4.7	(a) 5.7	(a)	
Ho			1.3	(a)	
Er					
Tm					
Yb	5	3.4	(a) 3.76	(a) 5.7	(a)
Lu	0.73	0.59	(a) 0.61	(a) 0.8	(a)
Hf	2.9	3.2	(a) 2.76	(a) 3.9	(a)
Ta	0.3	0.33	(a) 0.33	(a) 0.36	(a)
W ppb					
Re ppb			<0.4	(c )	
Os ppb					
Ir ppb		6	(a) 2.8	(c ) 9.1	(a)
Pt ppb					
Au ppb			0.23	(c ) 2	(a)
Th ppm	1.4	0.7	(a) 1.6	(a) 1.7	(a)
U ppm			0.29	(a) 0.35	(a)

technique: (a) INAA, (b) fused bead emp, (c) RNAA